ISSUE 2 / 2014

INFORMATION – RESOURCES – ENERGY

CUTEC News

EDITORIAL

RECYCLING METAL FROM PROCESS WATER

Dear Reader,

As you will doubtless have noticed, we are establishing a new Metal Recycling research function within the Water Treatment division. It is a subject which fits perfectly with the strategy of creating a sustainable industrial society, particularly in relation to strategically key industrial metals.

But, be honest, did the headline to this article not also make you think of the "gold-rush" climate linked to the recovery of solid residues, otherwise known as "urban mining"? If it did, then your view is just like mine was before I took a closer look at the issues involved: You can no longer see the wood for the trees. The metal concentrations in process water treatment are already quite low; the actual resource alongside the metals is the water. The economic growth of some developing countries is today already linked directly to the availability of water. Water is one of the global "megatrends". Shortage of water inhibits economic growth, so the aim should be to recycle 100 % of all process water. Current state-of-the-art technologies do make that possible, but they are a long way from being commercially viable. There is a major need for ongoing research. This is also demonstrated by the German Federal Ministry of Education and Research (BMBF) sponsored "WATER REUSE" development project scheduled for this Autumn. It will mean that two birds can be killed with one stone, particularly with regard to process water containing metals. If you are interested and have the time, I recommend you read the position paper "Trends and prospects in industrial water engineering" recently published by the Process Net working group on "Production-integrated water and waste water engineering", which includes a vision of the state of the art as it might be in the year 2030 as well as setting out the challenges faced. Major German plant manufacturers exporting German environmental technology are today already facing the challenge of fishing more and more metals out of water with ever reducing residue concentrations. Outside of Germany, it is in some cases already more cost-effective to treat contaminated process water even further in order to attain the required purity level.

Within this context, good solutions are vital and, as you might well imagine, we have a few ideas of our own.

Best regards,

Michael Sievers
Head of the Department of Wastewater Engineering

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PROFESSOR FAULSTICH NEW ENERGY SYSTEMS COORDINATOR AT EFZN

Prof. Beck (left) and Prof. Faulstich

At its executive Board meeting in April 2014, the Lower Saxony Energy Research Centre EFZN elected Professor Martin Faulstich as Research Coordinator for Energy Systems and Process Energy Technology. He has taken over the role from Professor Hans-Peter Beck. The EFZN also welcomed a second new Research Coordinator, Professor Thomas Turek, to lead work on Energy Conversion and Refining. Commenting on the board's decision, Director of the EFZN Hans-Peter Beck said: "Both colleagues have made valuable contributions to scientific advances in their field in recent years, and are outstandingly well suited to their roles."

The EFZN operates a total of nine research divisions, each led by a professor from one of the member Universities (Clausthal, Braunschweig, Göttingen, Hannover and Oldenburg) as its scientific coordinator. The EFZN has more than 80 specialists working in the fields of natural sciences, engineering, law, social policy and economics, creating a transdisciplinary energy research organisation.

The key focus of the research division led by Professor Faulstich is comprehensive analysis of energy systems, particularly with regard to the interlinking of the conversion, transportation, distribution and storage processes, and the efficient use of energy. The Process Energy Technology division focuses on process optimisation, energy-saving and the transition to renewable energy sources.

The division's work thus encompasses current research and development issues linked to the switching of energy systems to a renewables base primarily reliant on solar and wind power. Within this electricity-based energy system, the areas of electric power, heat transportation and supply to the primary materials industry are linked by electricity as an energy source. Beneath the umbrella term "Power to All", research activities relating to the conversion of electric power into heat (Power-to-Heat) and into gaseous and liquid fuels and primary materials (Power-to-Gas, Power-to-Liquid) are being advanced further.

Professor Faulstich will focus especially on enhancing collaboration between the EFZN and the CUTEC Institute. As one example of that collaboration, staff from the Energy System Analysis department are already working at the EFZN in order to develop and manage joint projects on-site. Both organisations will benefit from the closer co-operation not just on a scientific level but also by utilising the already established infrastructures on-site. The existing energy infrastructure, for example, will be shared as much as possible. The first joint project submissions have already been made: The EFZN and the CUTEC Institute are working jointly to create sustainable and resilient energy systems. The aim is to develop proposals for the transformation of regional energy systems incorporating ecological, social, technical and (resource-related) economic criteria.

Professor Faulstich is looking forward to building the EFZN's Energy Systems and Process Energy Technology research division as a contribution to the interlinking of process and electrical engineering systems. (kr)

SOSTA – SORTING OF STEEL SCRAP

The Department of Metal Recycling is starting a preliminary study relating to the intelligent sorting of steel scrap, titled "SOSTA" for short. It is funded by the European Regional Development Fund (ERDF).

The background to this preliminary study is that large numbers of different alloy steels and steel grades are in circulation. Also there is the continuous launch of new and enhanced steel grades. These can be steels with high manganese content, for example, or combinations of different steel grades – so-called tailored blanks. Another approach currently being pursued in the steel industry are sandwich steels, comprising two extremely thin plates combined with an organic filler material. The European Steel Scrap Specification, with its classification in only 11 steel sorts, is applied for recycling of the wide variety of steels on offer. We in the Department of Metal Recycling believe that this classification is no longer fit for purpose, as it does not enable complete recycling of the alloy elements contained in the steels and the recovery of special scrap qualities. Moreover, these alloys and compounds are often galvanised to prevent corrosion. This highly heterogeneous mix of scrap materials and coatings means that an optimal recycling and reuse is not possible. The materials are mostly used to produce construction steels in electric arc furnaces. Strategically valuable alloy elements or scrap qualities contained in them, such as "non-alloyed" pure soft steels, cannot be recovered and are lost in the industrial recycling process.

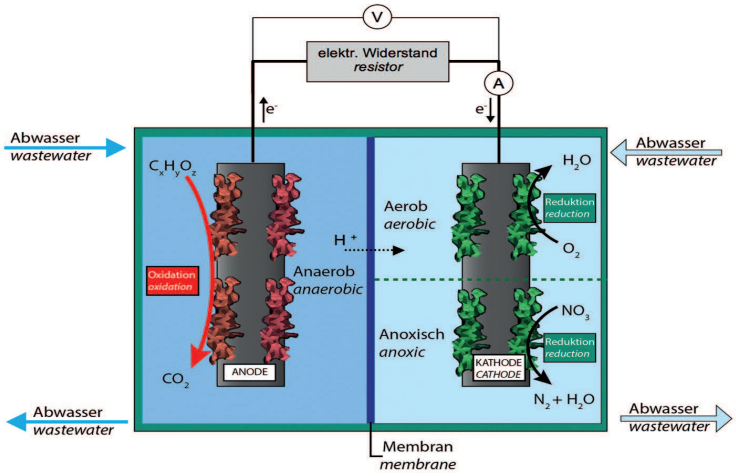
The aim of this preliminary study is to create a synopsis of steel qualities and compounds. Based on this synopsis a method is to be devised for intelligent sorting of heterogeneous scrap materials according to their actual component materials and not only based on the 11 different steel sorts.

The optained results are supposed to be the basis for a research project to increase the steel sorting accuracy, preferably in cooperation with industry in Lower Saxony. This measure would have a positive influence on the conservation of strategic alloy element resources, and as such would make a major contribution to protect the environment. This study is of major importance to large-scale industry and to small and medium-sized businesses in Lower Saxony, as there are strong steel and automotive industries as well as a well-established and innovative recycling sector. (sr)

KICK-OFF OF NEW "BIOBZ" PROJECT

May 1st this year marked the official start date of the joint project titled "BioBZ". Its subject: The bio-electrochemical fuel cell as a component of an energy-producing waste water treatment plant. The project was one of a total of 12 approved as part of the BMBF's ERWAS scheme to promote future-proof technologies and concepts for energy-efficient water resources management. The project is scheduled to run for 36 months and has a total volume of some three million Euros. Led by Professor Sievers, head of the CUTEC Institute's Department of Waste Water Process Engineering, the joint research project comprises a total of six partners from science, industry and the service sector (see picture below). The subject of the project is the development, analysis and evaluation of the bio-electrochemical fuel cell through to pilot scale. The project's website at www.bio-bz.de provides reports on the latest developments.

Bio-electrochemical fuel cells contain living micro-organisms which are able to produce electric power and/or hydrogen directly from complex organic substrates, such as the component substances in waste water (see picture above). Their achievable power density is much less than that of chemical fuel cells, but benign reaction conditions (room temperature, ambient pressure) and the use of waste water component substances as the primary energy source mean that the new method offers significant benefits. As well as directly generating electricity, bio-electrochemical fuel cells also save on the ventilation power needed for conventional waste water treatment. As such, bio-electrochemical fuel cells might be key in converting municipal sewage treatment plants into regenerative power plants. Major aspects of this are also the identification of integration options and assessment of the influence of this technology on treatment requirements and on the energy and heat management of treatment plants. Another key area of research focus is utilisation of the oxidation potential of bio-electrochemical fuel cells for parallel degradation of micro-pollutants, because in future the planned extension of the list of priority substances will mean that it will no longer be possible to consider waste water treatment and the degradation of such micro-pollutants as separate issues. As the solution proposed represents a new, largely unknown method, network-oriented industry bodies will be actively involved in disseminating the results of technical feasibility and sustainability studies (life-cycle assessment) and commercial viability analysis (in terms of operating cost and economic cost).



Functional schematic of a bio-electrochemical fuel cell

A three-year development phase will incorporate electrochemical and biochemical as well as process engineering and design aspects, in keeping with the complexity of the fuel cell system. In view of the many currently still unknown influencing factors, various concepts will initially be investigated in parallel, focusing mainly on real municipal sewage. The findings from those tests in relation to electrode material, cathode design, biofilm structure, current yield, degradation efficiency, electrode stacking, etc. will then be applied iteratively to design the stack structure for a pilot plant.

The design of the electrode stacks will incorporate consideration of the production engineering conditions at an early stage with a view to assuring cost-effective fabrication and assembly of components. Part of the plan is to develop, make and use appropriate machine tools for a small-lot production run. In parallel with this, standardised analytical methods will be devised to identify quality criteria so as to assure conformance to the material quality required for small-lot production in a reproducible way. Then electrodes and other components will be fabricated and assembled to create a modular electrode stack with associated control, voltage transformation and electricity storage systems. The pilot plant will then be installed and tested at the treatment facility in Goslar (Eurawasser). It is expected that the pilot trials will entail the need for iterative process and material improvements. The results of the pilot trials will then be applied by the CUTEC Institute's Department of Metal Recycling to assess ecological and economic impact. The marginal conditions and the application potential for integration into existing treatment plants will also be investigated and assessed.

An initial functional laboratory model of the bio-electrochemical fuel cell was presented on the CUTEC Institute's stand at this year's IFAT trade fair in Munich between May 5th and 9th. It attracted great interest from the large numbers of visitors who came to see it, sparking plenty of

CUTEC Informationen Ressourcen Energie — CUTEC-Institut
1. Abt. Abwasserverfahrenstechnik
2. Abt. Metallrecycling

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DVGW KIT — DVGW-Forschungsstelle am Engler-Bunte-Institut des Karlsruher Instituts für Technologie, FB Wasserchemie und Wassertechnologie

EISENHUTH — EISENHUTH GmbH & Co. KG

EURAWASSER — EURAWASSER Aufbereitungs- und Entsorgungs GmbH

Partners in the "BioBZ" project

CUTEC INSTITUTE SHOWS AT IFAT 2014 TRADE FAIR IN MUNICH

IFAT, the world's leading trade fair for water, sewage, waste and raw materials management, was held in Munich from May 5th to 9th, 2014. In addition to the well-known topics of this industry sector, the supporting programme featured presentations and discussions relating to the future industrialised society. One such event was the "intelligent urbanization" forum. Professor Faulstich explained during his presentation the necessary structural changes for a future in which 70 % of the global population will be living in cities. Also he highlighted the associated problems. Those challenges require new technological approaches up to technology evolutions. His presentation was received with great interest, and was intensively discussed afterwards.. Another meeting related to the subject of a proposed compulsory deposit on mobile phones to promote recovery and recycling (referred to in Germany as "Handypfand"). Environmental scientist Jan Schlecht from the CUTEC Institute presented the latest status of the project. Other CUTEC staff

Staff from the Department of Wastewater Engineering in dialogue

took part in a wide variety of meetings and events too.

The CUTEC Institute also hosted a large exhibition stand with the topic of Resources at the fair. It featured presentations of selected projects by the departments of Wastewater Engineering and Metal Recycling. Staff belonging to the departments were attending the stand. The

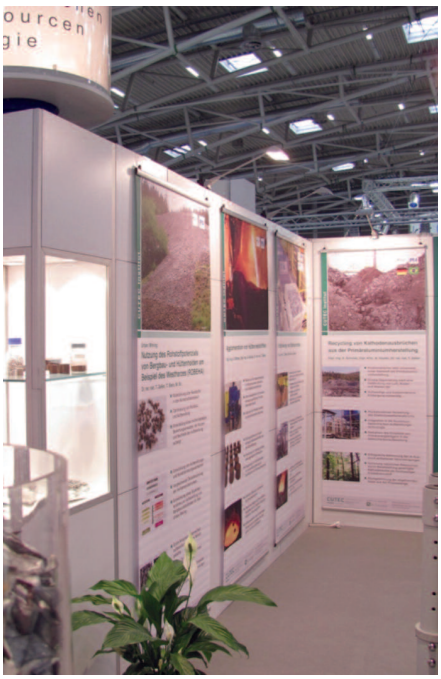
The complete CUTEC stand, featuring contributions from the departments of Wastewater Engineering (front left) and Metal Recycling (rear right)

project engineers were able to provide detailed answers to questions from interested professional visitors. The related discussions generated new impulses and ideas for future projects and research partnerships.

The exhibits shown attracted special attention. One of the topics featured was the bio-electrochemical fuel cell and its various positive effects when in operation in a sewage treatment plant. Another presentation related to starch-based flocculents, highlighting their already proven functionality and wide implementation range. The examples on display demonstrated the benefits of the research results obtained so far and served as a basis for further discussion. The exhibits on the subject of the dezincification of steel scrap likewise attracted considerable interest. Some guests were astonished to discover that rust can in fact be a good sign. In this project, rusting metal sheets demonstrate successful removal of the zinc-containing corrosion-protecting layer for the purposes of zinc recycling and cleaner steel scrap. The practical applications of all the projects presented were highlighted by the proximity of the stand to representatives of all kinds of industries.

The intensive discussions on the stand fortunately resulted in many promising new project ideas. Existing contacts with industry and project partners were enhanced and contacts were established. Consequently, the fair was a highly successful one for the CUTEC Institute.

We would especially like to thank the stand building team, who ensured that we had an excellent platform to present our expertise. (ditt)



Poster presentation by the Department of Metal Recycling on the stand at IFAT 2014

PRESENTATION OF THE MEMBERS OF THE NEW SCIENTIFIC ADVISORY BOARD

Profile in this issue: Prof. Dr.-Ing. Volker Wesling

Prof. Dr.-Ing. Volker Wesling

Professor Dr.-Ing. Volker Wesling has been closely linked to the CUTEC Institute for many years. In his role as Vice-President for Research and Technology Transfer of the Technical University of Clausthal, he chaired our former Scientific Advisory Board between 2009 and 2013. He regards the key strategic decision during that time as being the establishment and expansion of the Sustainability Management Cluster. The Cluster has since become the stand-alone Department of Metal Recycling, and is highly successful in the acquisition of third-party funding. Its creation paved the way to exploit the newly arising potential in the fields of energy and recycling. We are delighted that Prof. Wesling will be continuing to contribute to the scientific work of our organisation as a member of the Clausthal teaching staff following the end of his chairmanship.

As he states, his aims are: "to establish research in the field of environmentally friendly production methods in Clausthal, thereby helping small and medium-sized enterprises in particular to get fit for the future and enhance their innovative capabilities."‘ As part of those efforts, he is looking to enhance the collaboration between CUTEC and TUC, particularly in relation to the Department of Mechanical Engineering and the recently launched Clausthal Center for Materials Technology, as well as driving forward joint research submissions. He cites interfaces as relating to topics such as material-oriented joining techniques or recycling-friendly design incorporating the complete process chain.

Prof. Wesling was born in 1962 in Hildesheim. He first undertook an apprenticeship in precision mechanics with the Blaupunkt company in his home town. In 1984 he began studying mechanical engineering at the Technical University of Clausthal. In 1989 he was appointed a member of the scientific staff at the Institute of Welding and Machining, where he also gained his doctorate in 1993.

He spent the next nine years working in the engineering industry, including senior management roles with the former Mannesmann concern, where he in particular headed the Production, Manufacturing and Materials Development functions.

In 2002 Prof. Wesling returned to his alma mater, being appointed Professor of Welding and Machining at the Technical University of Clausthal. He has since that time been Director of the institute of the same name. Since 2005 he has additionally performed a wide variety of roles in university politics, including as a member of the Senate, Dean of Studies, and Pro-Dean. From 2009 to 2013 he was Vice-President for Research and Technology Transfer. Since 2007 he has been a member of the executive boards of the Clausthal Center for Materials Technology and the Scientific Society for Joining Technology. In 2007 he was appointed Honorary Professor at the Kyrgyz State Technical University "I. Razzakov" in Bishkek. From 2009 to 2013 he was a member of the executive board of the Laser Centre Hanover, and subsequently a member of that organisation's scientific advisory board.

In 2010 Prof. Wesling was appointed spokesman of the executive board of the Clausthal Center for Materials Technology. Since 2011 he has held two further memberships: on the executive board of the Lower Saxony Production Engineering Centre and on the research board of the Düsseldorf-based Research Body of the German Association of Welding and Related Techniques.

Prof. Wesling has published approximately 150 scientific papers, and holds six patents. His scientific work is focused on the following areas: Production of wear- and corrosion-proofing layers; low-temperature joining and welding processes; machining; and material-oriented production techniques in relation to fuel cells. (kra)

CUTEC IN BRAZIL

IEPALT project

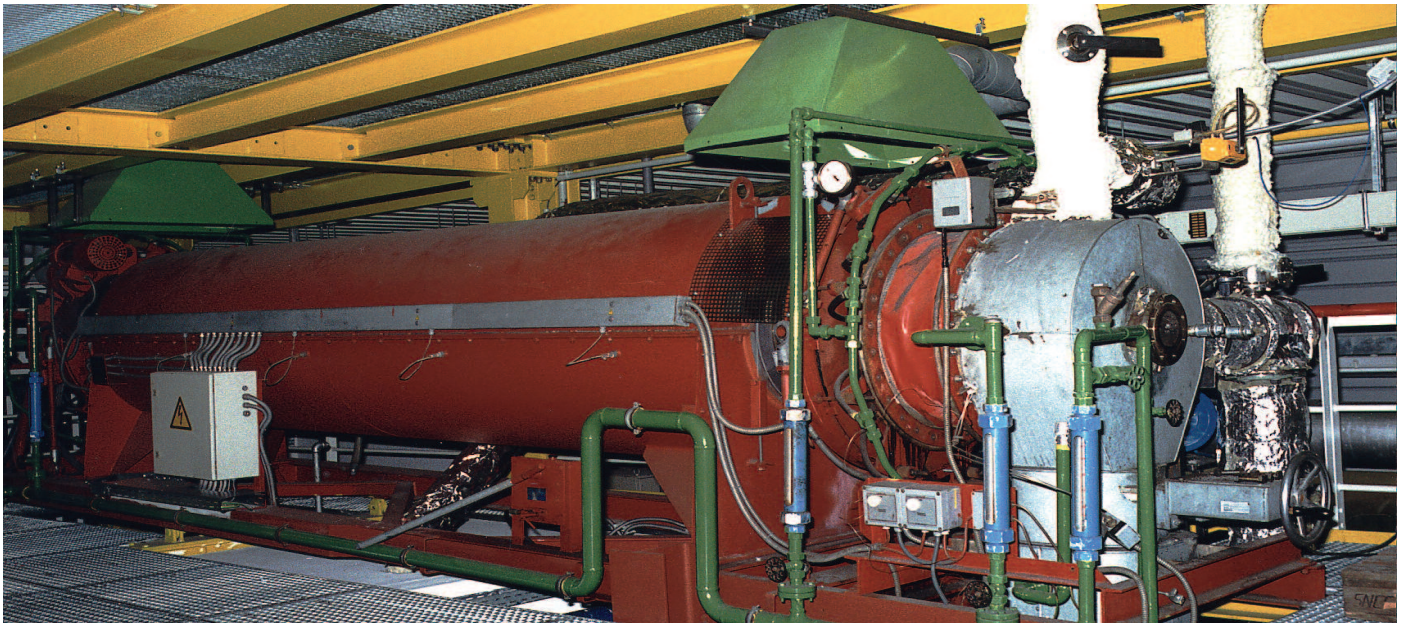
In February of this year a scientific exchange was undertaken with the South American research partners in the "IEPALT" project relating to the integration of spent pot linings from primary aluminium production into aluminium recycling technology. Representatives of the Department of Metal Recycling travelled to Canoas, in the Brazilian state of Rio Grande do Sul, to visit research partner ULBRA (Universidade Luterana do Brasil).

During the visit, intensive discussions were held on the progress of the project to date. It was agreed that the collaboration would be extended to more areas of research. Joint experiments and workshops were also conducted on-site at ULBRA.

Following on from the scientific exchange, an inspection tour of the project was made by Dr. Mennicken from the German Federal Ministry of Education and Research (BMBF), Ms. Hauschild from the project funding organisation Jülich (PtJ) and Ms. Parisius from the German national aeronautics and space research centre DLR. Over the course of several days, the Brazilian research partner took the opportunity to present the latest status of development activities. The programme was rounded off by an inspection visit to industrial project partner Recicla Alumínio Ltda. in Araçariguama, in the state of Sao Paulo. The company is planning to implement the research results, and is currently conducting industrial-scale trials. (schu)

Inspection visit to project partner

MINIMISING RESIDUES FROM PYROLYSIS PROCESSES



Pyrolysis rotary kiln at the CUTEC Institute pilot plant

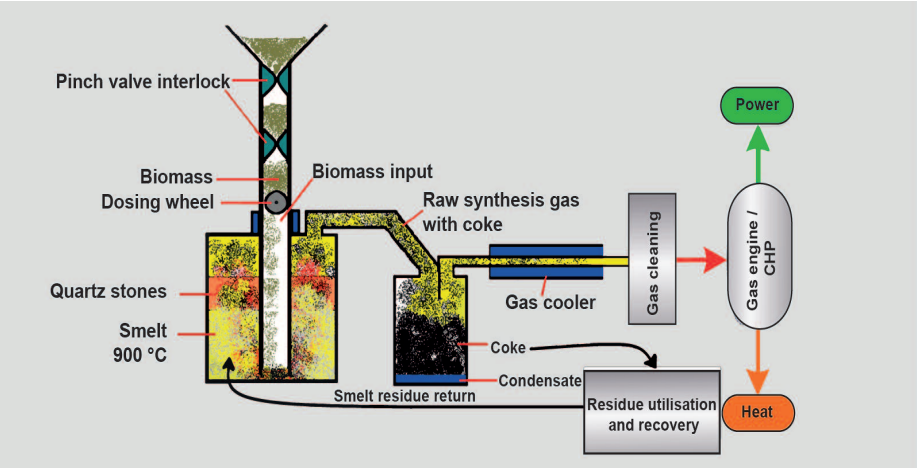
Biomass is a regrowable resource that will help to assure the world's energy supplies in future. It offers the advantage over other renewable energy sources, such as wind, water and solar, that it can be stored. To ensure responsible use of biomass, it is vital that the principles of sustainability and the need to preserve food sources are respected. Suitable materials are straw or fast-growing woods for example. Thermochemical conversion methods offer the advantage over biogas plants that biomasses containing lignin, such as switchgrass, miscanthus or straw, which biogas plants are unable to process, can be used to produce power and heat. Alongside incineration, biomass gasification and pyrolysis are conceivable methods of turning biomass into power. Pyrolysis guarantees a high calorific value of the gas produced as there is no oxygen present.

A feasibility study accompanied by trials on a pilot plant is being conducted to determine, among other findings, the extent to which the necessary cleaning of the pyrolysis gas can be simplified. Currently installed in a pilot plant are a condenser, a tar remover, a deduster and a desulphurisation unit. Analysis is being carried out to determine whether complex and costly separation of sulphur from the gas produced during pyrolysis is in fact necessary at all when using fuels with higher sulphur content such as straw. On the one hand, limit values of the gas engine suppliers must be complied with in order to avoid damaged inside the engine. On the other hand, limits on waste gas emissions from the CHP plant must also be observed.

A wet electrofilter can simultaneously remove tar and dust with minimal pressure loss. If desulphurisation could be omitted, a much simplified gas cleaning process would be available. The accompany trials seek to underpin the theory.

Ash produced by the alternative pyrolysis process being trialled contains residues from the metal smelt in which the pyrolysis is carried out. Separating those residues from the ash and recycling them greatly improves the cost-effectiveness of the process. At the same time, the possibility to spread the ash as fertiliser can be enhanced. Potential solutions will be demonstrated to meet the challenge of separating ash and metal smelting residues.

The project is being financed by the European Regional Development Fund (ERDF). (mü)



Process schematic

DIARY

- 7th Lower Saxony Summer School Fuel Cell and Batteries 15th to 19th September 2014, Technical University Braunscheig at the Haus der Wissenschaft

REPRESENTING CUTEC

ESSEN CONFERENCE

The 47th Essen Water and Waste Management Conference took place from March 19th to 21st. The keynote topic of this year's event was: "Is our water resources management system fit for the future?" This key question was chosen against the background of the new challenges which our water resources and waste management systems will have to confront in future. Existing municipal water management infrastructures will have to adapt to demographic change as well as to changes in precipitation events resulting from climate change. Changed social and environmental policy objectives in relation to resource conservation and energy management and recycling will also demand new and adapted concepts, process techniques and legal controls. Arndt Bachmann from the Department of Metal Recycling gave a presentation titled "Raw material potential of mining and steelmaking slag based on the example of slag heaps in the Harz Mountains" as part of the Conference's "Urban Mining" block. The CUTEC Institute also hosted an information stand as part of the accompanying exhibition. Stand hosts Hinnerk Bormann and Michael Niedermeiser from the Department of Waste Water Process Engineering were able to engage in some interesting dialogue on concrete project plans and on current and future activities of the CUTEC Institute.

Interchange on the CUTEC information stand

REVIEW OF THE HANNOVER INDUSTRIAL FAIR

The world's leading industrial trade fair, attracting over 180,000 visitors, took place from April 7th to 11th in Hannover. The CUTEC Institute participated alongside other businesses and research institutions on the joint "Energy and Mobility from Lower Saxony" stand. In the very popular hall 27 devoted to "Energy & Mobil Tec", the state of Lower Saxony presented features on Geothermal energy/Energy management, Wind power, Solar technology, Bioenergy, Energy storage/ systems, as well as the showcase feature Electromobility.

CUTEC presented an autonomous propane-based highly thermally integrated SOFC system developed as part of a joint research association within the state of Lower Saxony (see CUTEC News April 2014). This year saw the first results being presented, demonstrating the successful operation and high efficiency of the system. They also once again documented the continuity of our long-standing research into fuel cell systems.

The many interested visitors to the stand took the opportunity to find out generally about the latest status of research activities at the CUTEC Institute and to discover more on the specific subject of the SOFC fuel cell. Project partners and visitors from the spheres of industry and science studied the system in detail and discussed potential follow-up projects.

Governor of the state of Lower Saxony Stephan Weil also visited the stand. He was greatly impressed with all that he saw, and particularly praised the collaborative approach adopted on the project. He regards bundling of the extensive expertise available in the state, incorporating inter-disciplinary cooperation, as the ideal way to ensure that innovative solutions are developed. The Governor highlighted the core concept underpinning Lower Saxony's funding policy, focused on the shift in energy use, conservation of resources, and protection of the environment. The SOFC system presented at the fair fits perfectly within those policy principles. (di)

KASSEL WASTE CONFERENCE

VThe 26th Kassel Waste and Bioenergy Forum, hosted by the Witzenhausen Institute for Waste, Environment and Energy, was held in Kassel from April 8th to 10th, 2014. Under the scientific direction of Prof. Klaus Wiemer and Dr. Michael Kern, a select number of high-ranking scientists, policy-makers and business experts provided the attentive audience with a comprehensive and interesting insight into complex issues surrounding the conservation of resources, the shift in energy use, and avoidance of waste.

A range of forums offered a detailed insight into topics such as bioenergy and biowaste treatment, electronic scrap and recyclable materials, and management of material flows, as well as enabling lots of opportunity for lively debate.

Prof. Faulstich during his presentation at the Kassel Waste Conference

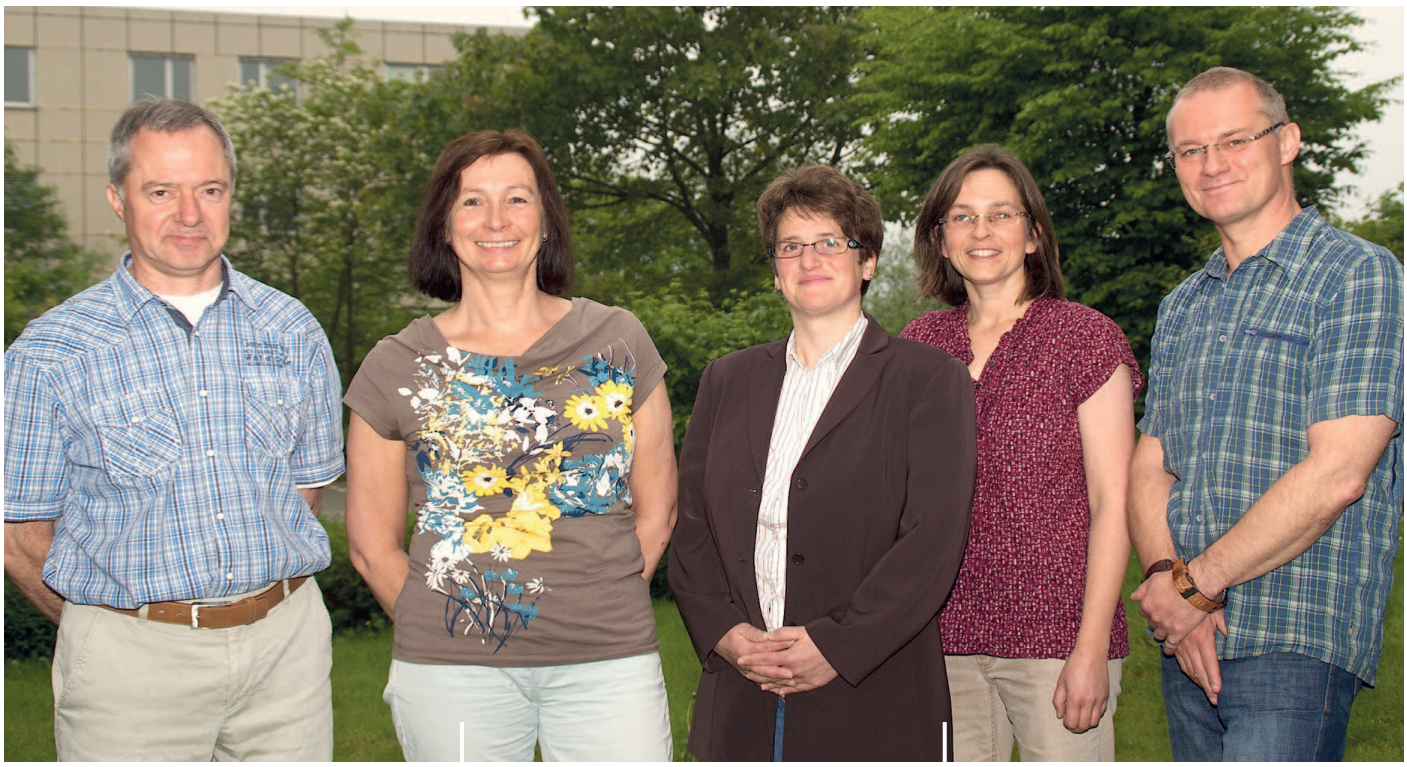
The CUTEC Institute was represented at the Forum by Prof. Martin Faulstich, who gave a presentation on the subject of "The shift in energy and resource use", as well as by Dr. Torsten Zeller, Dr. Nina Roth, Anne Dittmar and Thore Stein.

The CUTEC Institute hosted a stand in the exhibition accompanying the Forum which attracted numerous visitors keen to find out about our current projects and more generally about key areas of our research activities and potential new areas of focus.

A convivial evening event was also warmly appreciated. (st)

REPORT FROM THE WORKS COUNCIL

Elections



The new Works Council (from left): Dipl.-Ing. Milan Davidovic, Dr.-Ing. Sabine Weineck, Dipl.-Ing. Annett Wollmann, Carmen Kiefer and Kay-Morten Schenk

CUTEC employees recently elected a new Works Council. The existing seven-member Works Council retired at the end of April 2014 after four years in office. Areas of their involvement during the mandate period included personnel recruitment, an in-company agreement relating to overtime working, participation on the occupational safety committee, organisation of the "Active Mini-break", as well as representing colleagues in contractual and pay-related matters.

The work of the outgoing Works Council was marked particularly in the past year by the change of company managing director. The monthly consultations with the former managing director were replaced in the course of 2013 by routine meetings with the new management. The new Works Council expressly welcomes the core commitment to transparency in communications.

No Works Council election can take place without the work of the election committee. We would therefore like to take this opportunity to thank the election committee most sincerely for their outstanding efforts in organising and conducting the election. We would also like to thank the colleagues for the high level of voter participation and the trust they thereby showed in us. Elected as members of the new Works Council were Milan Davidovic, Carmen Kiefer, Kay-Morten Schenk, Dr. Sabine Weineck and Annett Wollmann. The combination of experienced and new members ensures that the successful work of the Works Council will be continued. The constituting session of the newly elected Works Council took place on May 14th, 2014. Annett Wollmann was elected Chair of the Works Council, with Carmen Kiefer as her deputy. The other members of the Works Council are of course also available to deal with queries or concerns at any time.

Finally, we would like to thank the retiring Works Council members: Gerd Cronjäger, Markus Lenk, Hans-Adolf Teegen, Karl-Heinz Dammeyer (2010 – 2013), Werner Siemers (from 2013) and, not least, the long-serving Chair of the Works Council Dr. Torsten Zeller. (ki/wo)

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